BMI 567/667 Network Science and Biology – Principles, Programming, Analysis and Visualization
On Campus – Fall 2016
3 Credit Hours

PREREQUISITE:
Background in linear algebra and calculus and knowledge in statistics are expected. Some programming experience using an object-oriented programming language will be needed in order to complete the course projects.

COURSE INSTRUCTOR:
Guanming Wu, Ph.D., Adjunct Assistant Professor, Department of Medical Informatics and Clinical Epidemiology
Email: wug@ohsu.edu
Office: BICC 413
Office hours: by appointment

TEXTBOOK:

Required:

http://www.amazon.com/Networks-Introduction-Mark-

Non-required Additional Text for Reference:
COURSE DESCRIPTION:
Networks are everywhere: the Internet, social networks, epidemiological networks, protein-protein interaction networks, gene regulatory networks, etc. This course will introduce students to basic concepts shared by many different kinds of networks, with focus on biological networks as examples. Students will learn how to program against networks, search for patterns hidden in networks, and visualize networks generated from real biological data sets.

COURSE OBJECTIVES:
After this course, students will have basic concepts and skills to analyze network data, and should be able to apply network-based approaches to their own research projects.

COURSE OUTLINE:
- **Principles**
  1. Introduction
     a. Ubiquitousness of networks
     b. Technological networks
     c. Social networks
     d. Networks of information
     e. Biological networks
  2. Fundamentals of Network Theory I: Mathematics of networks
     a. Networks and their representation
     b. Directed and un-directed, weighted and unweighted networks
     c. Degree, paths, components
     d. Graph Laplacian and Random walks
  3. Fundamentals of Network Theory II: Measures and metrics
     a. Centrality, transitivity, reciprocity, and similarity
     b. Community structure and small world
     c. Application in biology
• Programming
  4. Network data model in software
     a. Concepts in Object-oriented Programming (OOP)
     b. Network data modeling in OOP
     c. Storing network data: SQL and NoSQL for network
     d. Parallel computing for network data
  5. Program network data
     a. Fundamental network algorithms
     b. Matrix algorithms and graph partitioning
     c. Network community detection and its application
     d. Introduction to popular network software libraries

• Analysis
  6. Network models for analysis
     a. Random graph models
     b. Small-world and network growth models
     c. Exponential random graph models
     d. Network resilience
  7. Networks for systems biology
     a. Bird’s-eye view of systems biology
     b. Constraint-based systems biology modeling
     c. Boolean network and Petri-network
     d. Agent-based modeling
  8. Probabilistic graphical models
     a. Markov models
     b. Bayesian models
     c. Factor graph models
     d. Learning and inference

• Visualization and Application
  9. Visualization
     a. Importance
     b. Software tools: Cytoscape
     c. Graph layout
     d. Programming in visualization
  10. Application
     a. Protein function prediction
     b. Protein interaction network prediction
     c. Network based cancer signature development
     d. Other application examples.

METHODS OF EVALUATION:
Students will be evaluated on written assignments, a mid-term project proposal and a final project with a presentation.

Homework: There will be weekly written homework assignments posted on-line before class.
**Project:** Ph.D. students will be asked to finish the course projects in their own research fields, and M.S. students will have an option to use data sets provided in the course. They will present their project proposals at the mid-term, finish the projects, and present their results at the final.

Grades will be assigned based on the following criteria:

- A: 94-100%
- A-: 90-93.9%
- B+: 87-89.9%
- B: 84-86.9%
- B-: 80-83.9%
- C+: 77-79.9%
- C: 74-76.9%
- C-: 70-73.9%
- D+: 67-69.9%
- D: 64-66.9%
- D-: 60-63.9%
- F: Below 60%

Grades will be based on: Homework assignment 30%; Project 40%; Class Participation 30%. Students are strongly encouraged to participate in class discussion and attend to all lectures to get the full credit for “class participation”.

Graduate Studies in the OHSU School of Medicine is committed to providing grades to students in a timely manner. Course instructors will provide students with information in writing at the beginning of each course that describes the grading policies and procedures including but not limited to evaluation criteria, expected time needed to grade individual student examinations and type of feedback they will provide.

Class grades are due to the Registrar by the Friday following the week of finals. However, on those occasions when a grade has not been submitted by the deadline, the following procedure shall be followed:

1) The Department¹ /Program Coordinator² will immediately contact the Instructor requesting the missing grade, with a copy to the Program Director and Registrar.

2) If the grade is still overdue by the end of next week, the Department¹ /Program Coordinator² will email the Department Chair directly, with a copy to the Instructor and Program Director requesting resolution of the missing grade.

3) If, after an additional week the grade is still outstanding, the student or Department¹ /Program Coordinator² may petition the Office of Graduate students for final resolution.

¹ For courses that are run by a specific department.
COPYRIGHT INFORMATION:
Every reasonable effort has been made to protect the copyright requirements of materials used in this course. Class participants are warned not to copy, audio, or videotape in violation of copyright laws. Journal articles will be kept on reserve at the library or online for student access. Copyright law does allow for making one personal copy of each article from the original article. This limit also applies to electronic sources.

To comply with the fair use doctrine of the US copyright law, Sakai course sites close three weeks after grades are posted with the Registrar. Please be sure to download all course material you wish to keep before this time as you will have no further access to your courses.

SYLLABUS CHANGES AND RETENTION:
This syllabus is not to be considered a contract between the student and the School of Medicine. It is recognized that changes may be made as the need arises. Students are responsible for keeping a copy of the course syllabus for their records.

SYLLABUS STATEMENT REGARDING DISABILITY SERVICES
OHSU is committed to providing equal access to qualified students who experience a disability in compliance with Section 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act (ADA) of 1990, and the ADA Amendments Act (ADA-AA) of 2008. If you have a disability or think you may have a disability (physical, sensory, chronic health, psychological or learning) please contact the Office for Student Access at (503) 494-0082 or studentaccess@ohsu.edu to discuss eligibility for academic accommodations. Information is also available at www.ohsu.edu/student-access. Because accommodations may take time to implement and cannot be applied retroactively, it is important to have this discussion as soon as possible. All information regarding a student’s disability is kept in accordance with relevant state and federal laws.

ACADEMIC HONESTY:
Course participants are expected to maintain academic honesty in their course work. Participants should refrain from seeking past published solutions to any assignments. Literature and resources (including Internet resources) employed in fulfilling assignments must be cited. See http://www.ohsu.edu/xd/education/library/research-assistance/plagiarism.cfm?WT.rank=1 for information on code of conduct for OHSU and http://www.ohsu.edu/xd/education/teaching-and-learning-center/for-students/index.cfm for more information on citing sources and recognizing plagiarism.
In an effort to uphold the principles and practice of academic honesty, faculty members at OHSU may use originality checking systems such as Turnitin to compare a student’s submitted work against multiple sources.

To protect student privacy in this process, it will be necessary to remove all personal information, i.e. student name, email address, student u-number, or any other personal information, from documents BEFORE submission.

USE OF SAKAI:
This course will have an online component, which can be accessed through Sakai, OHSU’s online course management system. For any technical questions or if you need help logging in, please contact the Sakai Help Desk.

Hours: Sakai Help Desk is available Mon – Fri, 8 am – 9 pm and weekends 12 pm – 5 pm Pacific Time. The Sakai Help Desk is closed on all OHSU-observed holidays.
Contact Information:
(Toll-free) 877-972-5249
(Web) http://atech.ohsu.edu/help
(Email) sakai@ohsu.edu

INCLEMENT WEATHER POLICY:
When the weather forecaster is calling for ice or snow, call the OHSU Alert Line, 503 494-9021, for information regarding weather conditions that may affect operations at OHSU. This hot line will offer specific recorded messages for road conditions on OHSU's Marquam Hill and West campuses (option 1), and for patients (option 2), students (option 3) and employees (option 4). If extreme weather conditions present potentially unsafe situations, the provost of the university may choose to delay or cancel classes, or alter office and research activities. If classes are canceled or delayed, residents and students who have patient care responsibilities must meet those obligations.

For more information, please view the website http://www.ohsu.edu/xd/about/visiting/weather/index.cfm or call the above hotline.

DMICE COMMUNICATION POLICY
1. If the syllabus directs the student to contact the TA before contacting the instructor, the student should do so. Otherwise, the student should contact the instructor and allow 2 business days (not including weekends) for a response.
2. If the student does not receive a response from the instructor within 2 business days, s/he should contact the TA (if there is one). When contacting the TA s/he should cc the instructor and Diane Doctor at doctord@ohsu.edu.
3. If a student does not receive a response from the TA within 1 business day (not including weekends), s/he should contact Diane Doctor at doctord@ohsu.edu and cc the instructor and the TA.
4. If Diane does not reply within 1 business day (not including weekends), the student should contact Andrea Ilg at ilgan@ohsu.edu.

5. Students having difficulties with Sakai should contact the Sakai Help Desk at sakai@ohsu.edu or at (877) 972-5249. Sakai help is available M-F from 8am to 10-pm and weekends from Noon to 5pm. Do not contact the instructor.